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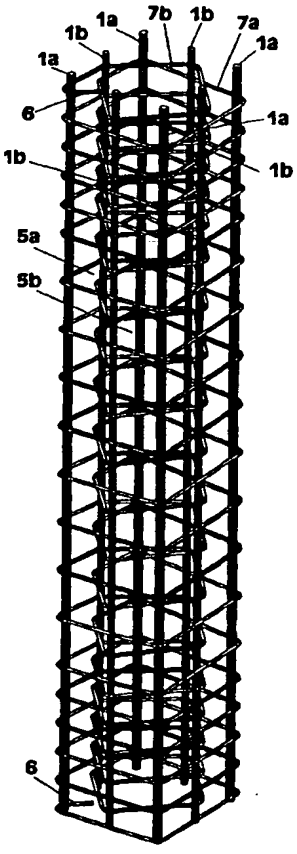
(57) Abstract

The present invention refers to stirrups for reinforcement of load bearing structural elements, and in particular for reinforcing concrete load bearing building elements, such as columns, shear walls, beams, slabs, footings, lintels, piles. The invention refers also to a method for reinforcing structural elements as well as to these elements. A stirrup for reinforcing load bearing elements according to the invention consists of a plurality of consecutive windings (7a, 7b) disposed along the longitudinal direction of the stirrup, so that the stirrup has a spiral form, whereby the windings of the stirrup form a plurality of discrete cages (5a, 5b) to house the main reinforcement bars (1a, 1b) of the load bearing element. The stirrups may be used for the reinforcement of load bearing elements of various cross sections such as orthogonal, T–shaped, L–shaped, Z–shaped etc.



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Antiseismic spiral stirrups for reinforcement of load bearing structural elements

The present invention refers to stirrups for reinforcement of load bearing structural elements, and in particular for reinforcing concrete load bearing building elements, such as columns, shear walls, beams, slabs, footings, lintels, piles. The invention refers also to a method for reinforcing structural elements as well as to these elements.

Stirrups and ties constitute one of the most critical factors of quality and antiseismic strength of buildings. Essential factors for the liability of stirrups are the proper hooks at their ends and the bend diameter at corners. The hooks at the end of the conventional stirrups are absolutely necessary for ensuring the proper functioning of the stirrup or tie in case of a very strong earthquake, when the spalling of the concrete occurs and when the hooks is the only remaining anchorage mechanism.

The following stirrups are used in building industry today:

i) Individual stirrups **8**, which may be of various forms, such as described in **figure 1**. For individual stirrups it is essential to be fastened in a plurality of points to the principal reinforcement rods **1** of the reinforcement as well as to the woodform. Thus their assembly is complicated and has a high cost. The individual stirrups **8** comprise hooks **6**, for anchoring the stirrups to the load-bearing element of the structure.

ii) "Mantles", i.e. stirrup cages made of prefabricate welded meshes (**see figure 2**). These are made of standardised welded meshes in suitable machines. The partial replacement of common stirrups by the "mantles" or "stirrup cages" was the first attempt to transform the painful task of reinforcing the load bearing elements of the structure into an industrial process. However the manufacture of the mantles is done in two phases, and only part of the process may become an industrial one: The first phase is an industrial

process aiming in the production of plane meshes, such as shown in **figure 3**, from steel rolls using huge machines. During the second phase the meshes are almost manually assembled to form stirrup cages. The production of 'mantles" have the following limitations: a) it is difficult to manufacture compound stirrup shapes by analysing them in simple rectangular shapes, b) it is impossible to increase or decrease the spacing of the stirrups resulting in superfluous weight of the reinforcement, c) it is expensive to transport them due to the size of the cages, d) it is difficult to manufacture double hooks, which is a necessity in antiseismic structures, and e) there is a danger of buckling of the vertical binding bars in case of an earthquake.

iii) Circular or orthogonal spiral stirrups such as disclosed in EP-A-0152397. Numerous experiments have been executed with circular spirals, which proved that if the spacing of the windings, i.e. the pitch, is kept below a minimum distance, the spirals are actually functioning like steel closed mantles, whose strength is increased due to the presence of triaxial stress system. The spiral stirrups currently known are appropriate only for reinforcing columns with rectangular cross-section. Further they are uneconomical because of the constant spacing between windings, which is determined by the shear level at the most critical region of the member. They also present problems in manufacturing and difficulties in placing them by the skilled workmen, because of the excessive weight in cases of strongly reinforced columns with many sides.

An object of the present invention is a stirrup overcoming the problems of the known stirrups. A further object of the invention is a stirrup which may be used for reinforcing load bearing elements of various cross-sections such as columns, shear walls, beams, slabs, footings, lintels, piles.

An object of the invention is also a method for reinforcing the load bearing elements of a structure as well as such an element.

A stirrup for reinforcing load bearing elements according to the invention consists of a plurality of consecutive windings disposed along the longitudinal direction of the stirrup, so that the stirrup has a spiral form, whereby the windings of the stirrup form a plurality of discrete cages to house the main reinforcement bars of the load bearing element.

In accordance with a method of the invention for reinforcing a load bearing element, the principle bar elements of the reinforcement are housed within the windings of a spiral shaped stirrup whereby the stirrup comprises a plurality of cages, with each cage tightening a different set of principal bar elements.

A load bearing element according to the invention, comprises principle bar elements housed within the windings of a spiral shaped stirrup, whereby the stirrup comprises a plurality of cages, with each cage tightening a different set of principal bar elements.

Stirrups in accordance with the invention have a spiral form, so that the axial load carried by the stirrup may continuously transmitted with no interruption along its length. The windings of the stirrups of the invention form more than one cages for the principal reinforcement rods, so that they may be used for the reinforcement of load bearing elements of various cross sections such as orthogonal, T-shaped, L-shaped, Z-shaped etc. The stirrup may be brought in site compressed, and stretched during its positioning around the principle reinforcement rods. Its attachment to the reinforcement rods requires a relatively low number of fastenings – it is enough to fasten each winding to four or even three principle reinforcement rods - and involves relatively a low cost. The use of the stirrups of the invention allows the manufacture of the transverse reinforcement, which is essential for antiseismic and other reasons, to become an industrial process with low manufacturing cost and high quality of the product.

Stirrups according to the invention may be manufactured from a steel grade with very high strength, for example S1200 (1200MPa), because there is no

need to use hooks for anchoring, which are usually the weak points of the known stirrups. A further advantage of the stirrups of the invention is that their production and the stirrups themselves, may be standardised so that they may be of high quality and they could be used for reinforcing standard types of load bearing elements.

The further features of the invention described in the dependent claims offer other advantages.

According to claim 2, the windings of the stirrup are periodically arranged, so that each cage is formed by every n-th winding where n is the number of cages.

The stirrup of claim 3 has exactly two cages. With such an arrangement it is possible to cover the reinforcements of a large number of load bearing elements.

The stirrup of claim 4 has at least four cages. Such a stirrup is adequate for load bearing elements having a relatively large number of principal reinforcement rods and/or relatively complicated cross-section.

Preferable shape of stirrups are defined in claims 5, 6, 7. According to claim 5 the stirrup has a cross section similar to the cross section of a load bearing element having at least on web and at least one flange. Such a cross section may be T, Z, double T or other.

Claims 8, 9 define preferable materials to be used for the production of the stirrups of the invention.

The preferable advancement of the windings in the longitudinal direction according to claim 10 renders the stirrup advantageous in the case of relatively high shear loads.

Claim 11 defines that the distance between consecutive windings is uniform, while according to claim 12 the pitch may vary. Thus more economically effective solutions are possible.

Claims 13 to 15 define stirrups according to the invention comprising two spiral elements.

Claim 16 defines a prefabricated load bearing element comprising a stirrup according to the invention, and claim 17 defines a method to use the stirrups for the reinforcement of walls.

The invention will now be described by way of examples and with reference to the accompanying drawings in which:

Figures 1, 2, 2a present the known stirrups.

Figure 3 shows a stirrup according to the invention fastened to the principal reinforcement rods of a column and **figures 3a** shows schematically this stirrup.

Figures 4a, 4b, 4c, 4d, 4e show schematically stirrups according to the invention for the reinforcement of columns.

Figures 5, 5a, 5b, 5c, 6, 6a, 6b, 6c, 6d, 6e and 7, 7a present spiral stirrups having L, T and cross-shaped cross-sections respectively

Figures 8, 8a, 9 present spiral stirrups, adequate for footings or beams.

Figures 10, 10a present a spiral stirrup, adequate for a load-bearing wall.

Figures 11a, 11b, 11c, 11d, 11e, 11f show stirrups according to the invention for the reinforcement of load bearing elements having a Z-shaped cross section.

Figures 12 present a spiral stirrup with variable pitch.

Figure 13 shows a stirrup according to the invention consisting of two spiral elemets shown in **figures 13a and 13b**.

Figures 14a, 15a, 16a, 17a present a method of reinforcing load-bearing elements in accordance to the invention applied to the elements shown **in figures 14, 15, 16, and 17.**

Referring to the attached drawings we shall describe some indicative examples of the antiseismic spirals according to the invention. These are spiral stirrups usually manufactured by robot machines, from coiled rods of Φ4 to Φ16 in steel rolls of every quality and grade. The use of the coiled rods provides the possibility to produce the stirrup in the shape of a spiral with no discontinuation, in one piece of compound shape. They are manufactured compressed and they are stretched with relative convenience during their placing. Stirrups according to the invention may be also made of composite materials, for example from glass fibres.

Figure 3 shows a stirrup according to the invention. The spiral stirrup of this figure has consecutive alternating windings **7a** and **7b**. The set of windings **7a** forms a cage **5a** to house the principal rods **1a** of the reinforcement. In use the windings **7a** are tightened around the rods **1a** and it could be enough to fasten each winding even to three rods. Similarly the set of windings **7b** form a cage **5b** to house the principal rods **1b** of the reinforcement. Thus the stirrup includes two cages **5a, 5b,** whereby each one of the cages **5a, 5b** is formed by the alternating windings **7a, 7b** respectively. The projections of windings **7a** on a transverse plane coincide, so that the cage **5a** is cylindrical or approximately cylindrical. Similarly cage **5b** is cylindrical or approximately cylindrical, as the projection of the windings **7b** on a transverse plane coincide. In the case of the stirrup of **figure 4** the pitch is constant along the length of the stirrup, so that not only the projections of windings **7a** coincide, but also the spatial shape of these windings is identical. The same applies for windings **7b**.

Figure 3a shows schematically a cross sectional view of the stirrup shown in **figure 3**, whereas **figures 4a, 4b, 4c, 4d, 4e** show cross sectional views of other stirrups to be used for the reinforcement of columns. The stirrup of **figure 4a** has two cages **5a, 5b** with overlapping cross sections, and **figure 4b** shows a stirrup with an almost rectangular cage **5b** within a polygonal cage **5a**. Such a stirrup may be formed with a circular or elliptical outer cage. Further stirrups for columns with rectangular cross-sections are shown in **figures 4c, 4d and 4e**.

Figures 5, 5a, 5b, 5c present spiral stirrups having L-shaped cross-sections comprising two (**see figure 5a**), three (**see figure 5b**) or four (**see figure 5c,** cages **5a, 5b, 5c, 5d**) cages. **Figures 6, 6a, 6b, 6c, 6d, 6e** present spiral stirrups with T-shaped cross sections, and **figures 7, 7a** a stirrup with a cross-head cross-section. T-shaped spiral stirrups, which are also used for the reinforcement of footings, have an excellent performance when they carry simultaneously shear, torsional and flexural loads.

Figure 8, 8a show a spiral stirrup to be used for the reinforcement of a beam or footing, with two overlapping cages **5a, 5b**, according the invention. With this arrangement a single spiral may be used for each footing or beam. **Figure 9** shows a spiral stirrup with three cages **5a, 5b, 5c** to be used for the reinforcement of a beam of a bridge.

Figure 10 shows the axonometric representation and plan view of a concrete shear wall with a spiral stirrup shown schematically in **figure 10a**.

Figures 11a, 11b, 11c, 11d, 11e, 11f show indicative representation of spirals for Z-shaped columns, which are often used at the corners of buildings.

With suitable programming of the production machine of the stirrup or appropriate fastening of the legs of the stirrup with the principal reinforcement rods, advancement of the windings along the length of the stirrup may be effected through longitudinal elements, while the windings remain at a

substantial transverse plane. Such an option allows the use of the spirals in beam elements and footings that carry relatively high shear forces.

The pitch of the windings may be uniform or variable, as shown in **figure 12**. The variation in pitch may be effected either during production or during the reinforcing of the load-bearing element. With this arrangement the optimum economical solution arises because the variation of the pitch of the spiral may follow the shear forces diagram. **Figure 12** shows the spiral stirrup of **figure 3**, divided in parts with constant pitch. For example for a distance of 0,5 m in the base and 0,5 m in the top of the member the pitch equals to 10cm and 12 cm respectively, whereas along the middle portion of the stirrup, which extends along a length of 2 meters, the pitch is 20 cm. This arrangement results in a highly efficient solution, since it strengthens the "critical regions" of the load-bearing element with shorter winding spacing. The stirrup of **figure 12** may be used for the reinforcement of a column, beam or other structural elements.

The stirrup of the invention may be manufactured by a continuous extruded steel rod or by parts. With this arrangement the spiral is constructed by a number of spiral elements manufactured individually. The spiral elements may be constructed by rod with the same or different cross-section and may have the same or different pitch. In order to form the stirrup the spiral elements are placed side by side along their longitudinal direction and their ends are joint, so that one spiral element extends on one side of the joint and the other on the other side thereof. The joints may be effected in various ways: For example the two ends to be joint may be provided with hooks having an angle >= 135°, and one spiral element may be fastened to the other through these hooks. Alternatively each end of the spiral elements is provided with a winding having a very small or even zero pitch which are welded together to effect the joint. Joint of the spiral elements may be also effected by the combination of the two previous arrangements. **Figure 13** shows a stirrup made of the two spiral elements **3', 3''**, shown schematically in **figures 13a, 13b**, which is to be used for the reinforcement of beams, columns or other structural elements.

The joint of spiral elements to produce a spiral with the features of the invention may be effected in site or it may be prefabricated

Figures 14a, 15a, 16a, 17a show the application of spiral stirrups in accordance with the invention, for the reinforcement of the shear wall elements shown in **figures 14, 15, 16, and 17** respectively. The walls may be of large sizes and in general they may have a rectangular, angular, lift type etc. cross sections. In accordance with the method the combination of regular size spiral stirrups with longitudinal rods **4**, which may have hooks **6'** - 90° or 135° or other angle – at their ends effects the reinforcement of the walls. Other ways of attachment of the rods to the stirrups are also possible. Spiral stirrups are placed at shear walls ends and they tied or welded to the longitudinal rods, which in the case of te examples shown in the figures, are normal or almost normal to the longitudinal direction of the stirrups. Although particular advantages are offered by this method of reinforcing when applied in combination with the spiral stirrups of the invention, other spiral stirrups may be also used.

The stirrups of the invention may be used for the reinforcemnet of prefabricated load bearing structural elements.

The embodiments of the invention described above are only examples of realisation of the invention and do not limit the extent of the protection sought.

CLAIMS

1. Stirrup for reinforcing load bearing elements consisting of a plurality of consecutive windings **(7a, 7b)** disposed along the longitudinal direction of the stirrup, so that the stirrup has a spiral form, whereby the windings of the stirrup form a plurality of discrete cages **(5a, 5b)** to house the main reinforcement rods (**1a, 1b**) of the load bearing element.

2. Stirrup **according to claim 1,** whereby the stirrup comprises n cylindrically- or approximately cylindrically-shaped cages, where n is an integer greater or equal to 2, and whereby the projections of each n-th winding provided along a portion at least of the length of the stirrup, on a transverse plane coincide.

3. Stirrup **according to claim 1 or 2,** whereby the stirrup comprises two and only two cages to house the main reinforcement rods of the load bearing element.

4. Stirrup **according to claim 1 or 2,** whereby the stirrup comprises at least four cages (**5a, 5b, 5c, 5d**) to house the main reinforcement rods of the load bearing element.

5. Stirrup **according to any of the proceeding claims,** whereby the projection of the stirrup on a transverse plane coincides to the cross section of a load bearing element comprising at least one web and at least one flange.

6. Stirrup **according to any of the claims 1, 2, 3, 5** whereby the shape of the windings on a transverse plane is orthogonal and adjacent windings are so disposed, that the long dimension of each winding is normal to the long dimension of its adjacent windings, so that the projection of the stirrup on the transverse plane is T like.

7. Stirrup **according to claim 1 or 2**, whereby in that the stirrup comprises an outer cage which houses all other cages of the stirrup.

8. Stirrup **according to any of the preceding claims**, whereby the stirrup is made of a continuous extruded steel rod.

9. Stirrup **according to any of preceding claims**, whereby the stirrups are made from composite material.

10. Stirrup **according to any of proceeding claims**, whereby the windings are disposed on substantially transverse planes and consecutive windings are joined by substantially longitudinal elements.

11. Stirrup **according to any of preceding claims**, whereby the distance between consecutive windings is uniform.

12. Stirrup **according to any of preceding claims**, whereby the distance between consecutive windings is variable.

13. Stirrup **according to any of preceding claims**, whereby the stirrup comprises two spiral elements (**3', 3''**) disposed longitudinally and joined at their ends, so that the one of the two elements extends towards one side of the said joined ends and the other of the two elements extends towards the other side of the said joined ends.

14. Stirrup **according to claim 13**, whereby the two spiral elements is welded together.

15. Stirrup **according to claim 13 or 14**, whereby the first and/or the second of said elements are stirrups **according to any of the claims 1 to 12**.

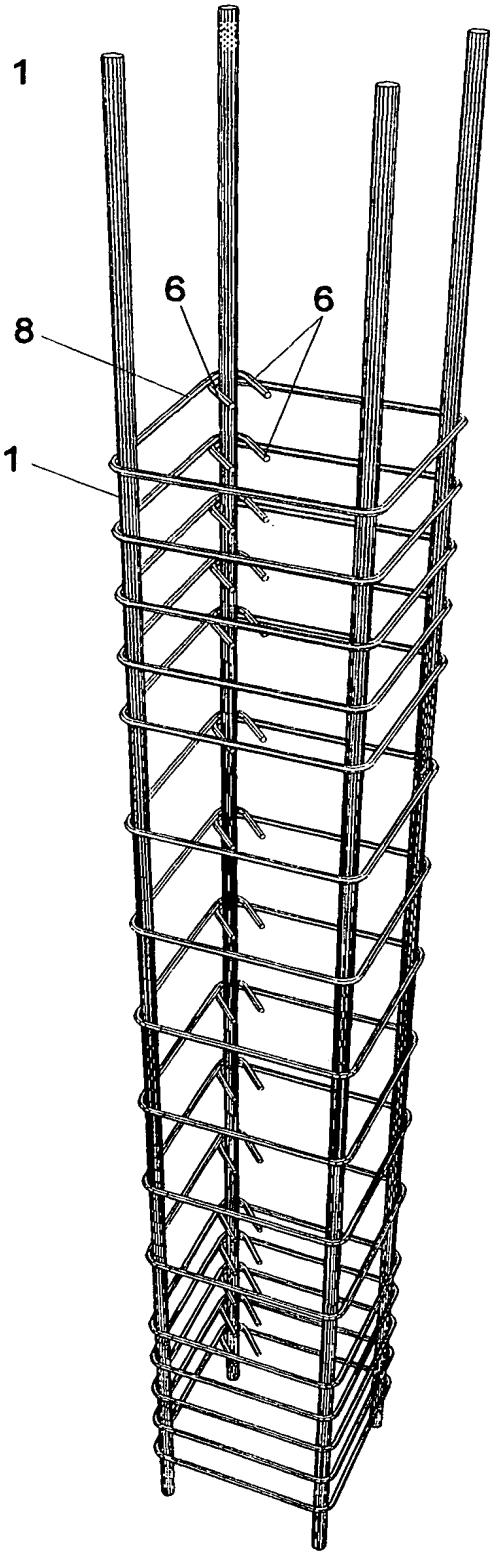
16. A prefabricated load bearing element comprising a stirrup **in accordance with any of the claims 1 to 15**.

17. Method of reinforcing of shear wall elements using the stirrups of **any of the claims 1 to 15**, whereby the reinforcement of the wall is effected by joining at least two of the said stirrups with reinforcement rods (**4**).

18. Method of reinforcing a load bearing element whereby the principle rod elements of the reinforcement are housed within the windings of a spiral shaped stirrup, and whereby the stirrup comprises a plurality of cages **(5a, 5b)**, with each cage **(5a, 5b)** tightening a different set of principal rod elements.

19. A load bearing element whereby the principle bar elements of the reinforcement are housed within the windings of a spiral shaped stirrup whereby the stirrup comprises a plurality of cages **(5a, 5b)**, with each cage **(5a, 5b)** tightening a different set of principal rod elements.

Figure 1



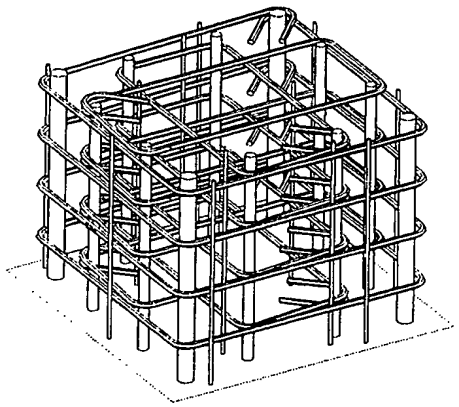


Figure 2

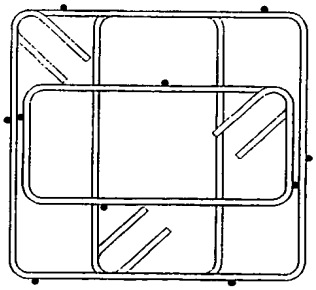


Figure 2a

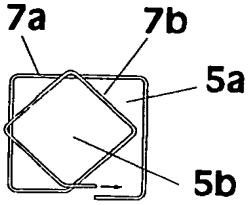


Figure 3a

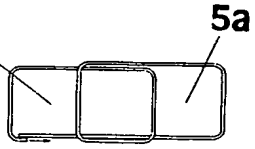


Figure 4a

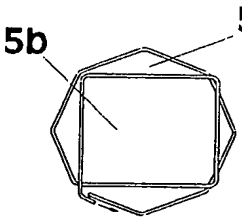


Figure 4b

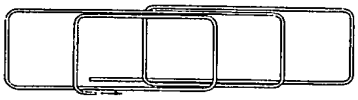


Figure 4c

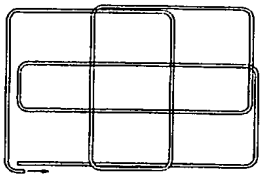


Figure 4d

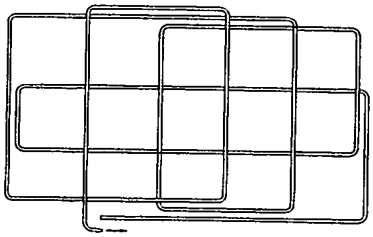


Figure 4e

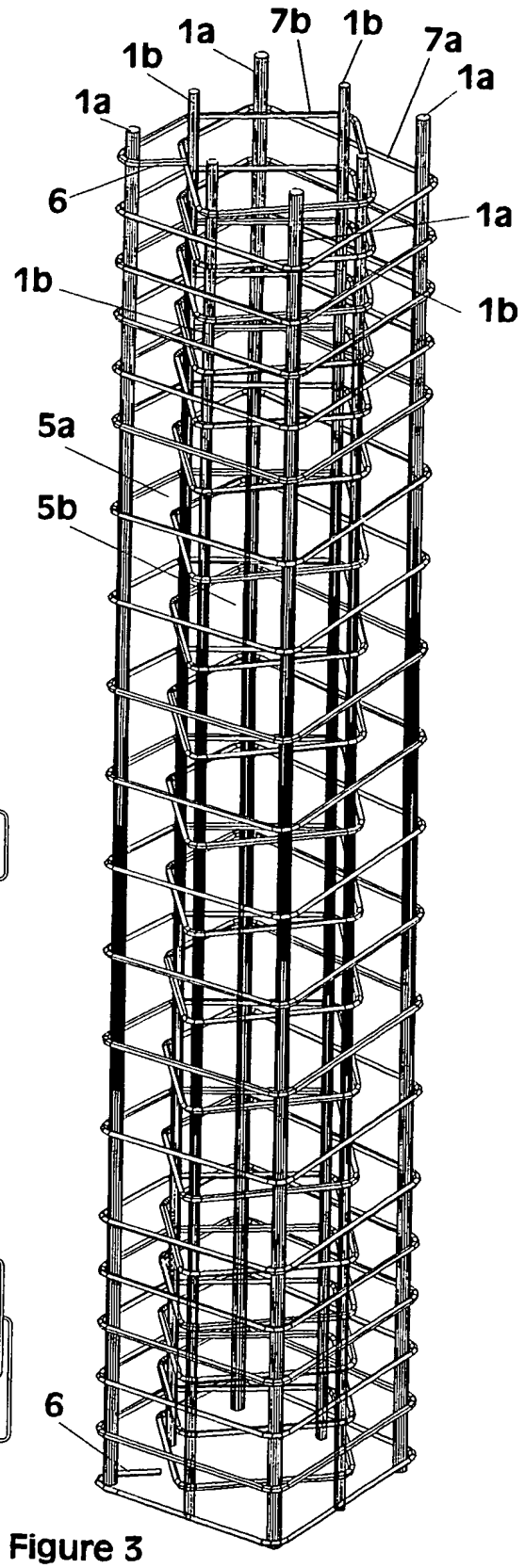


Figure 3

Figure 5a

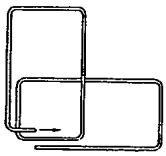


Figure 5b

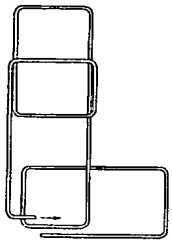
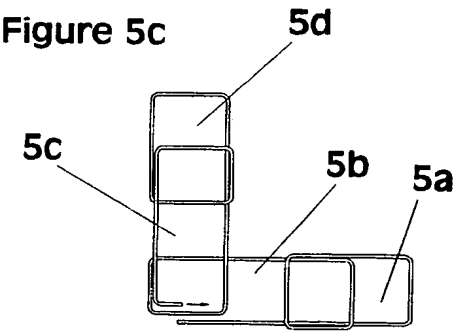


Figure 5c



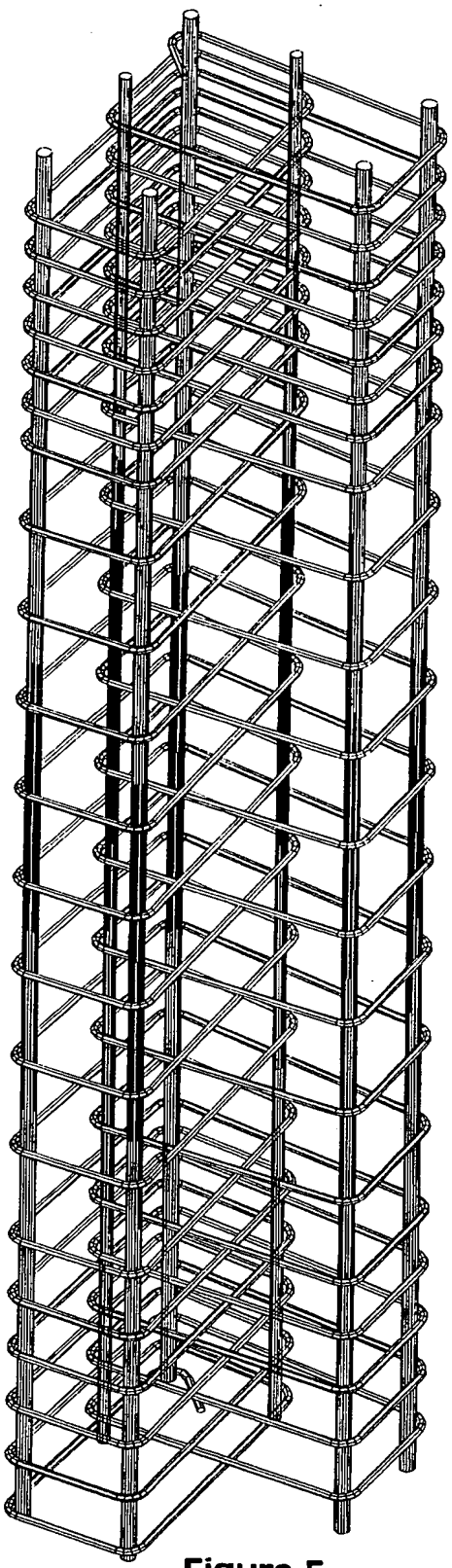


Figure 5

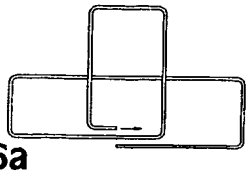


Figure 6a

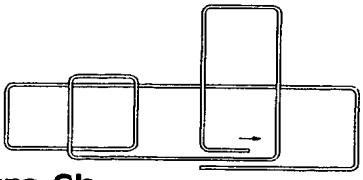


Figure 6b

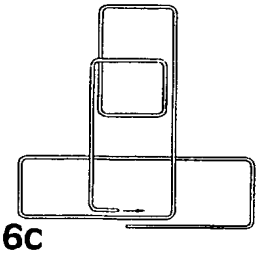


Figure 6c

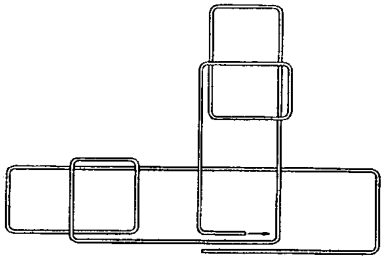


Figure 6d

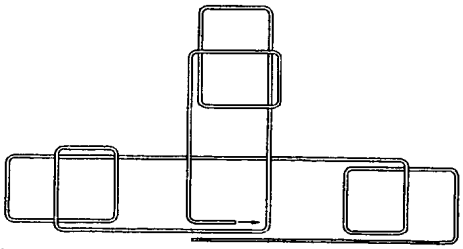


Figure 6e

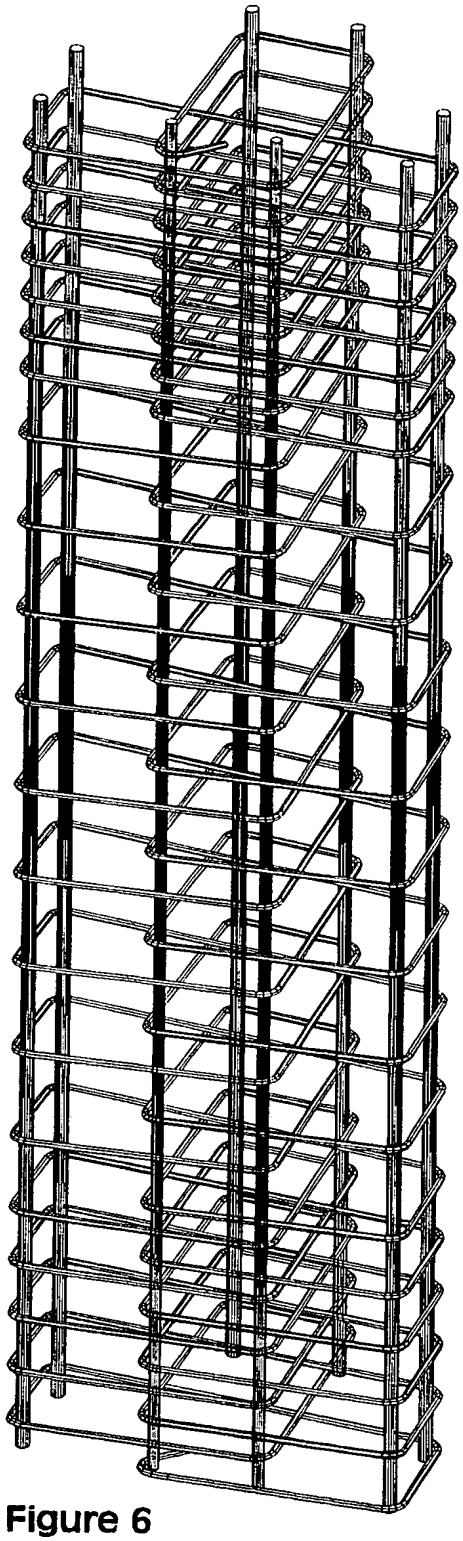


Figure 6

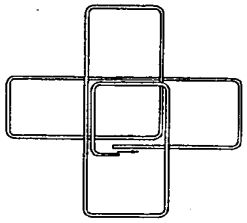


Figure 7a

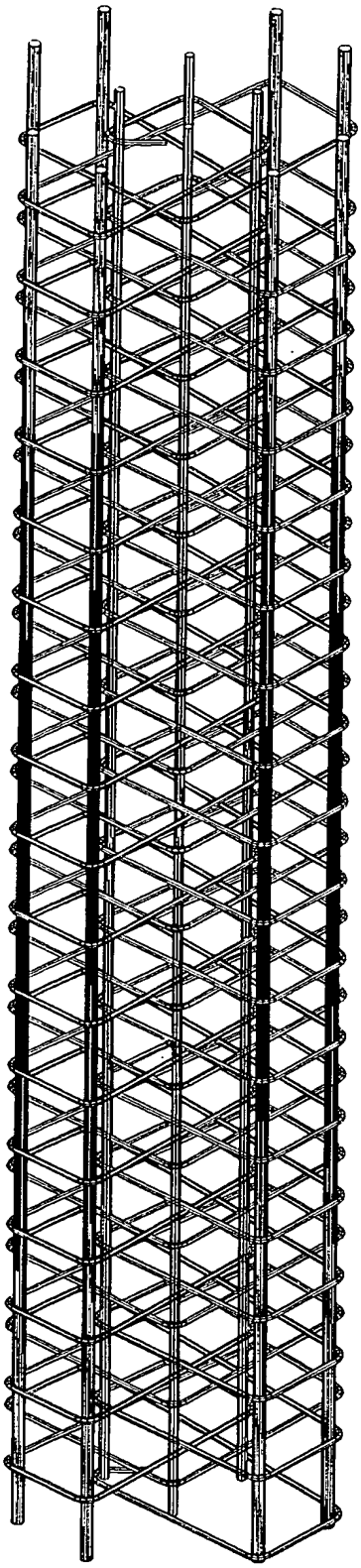
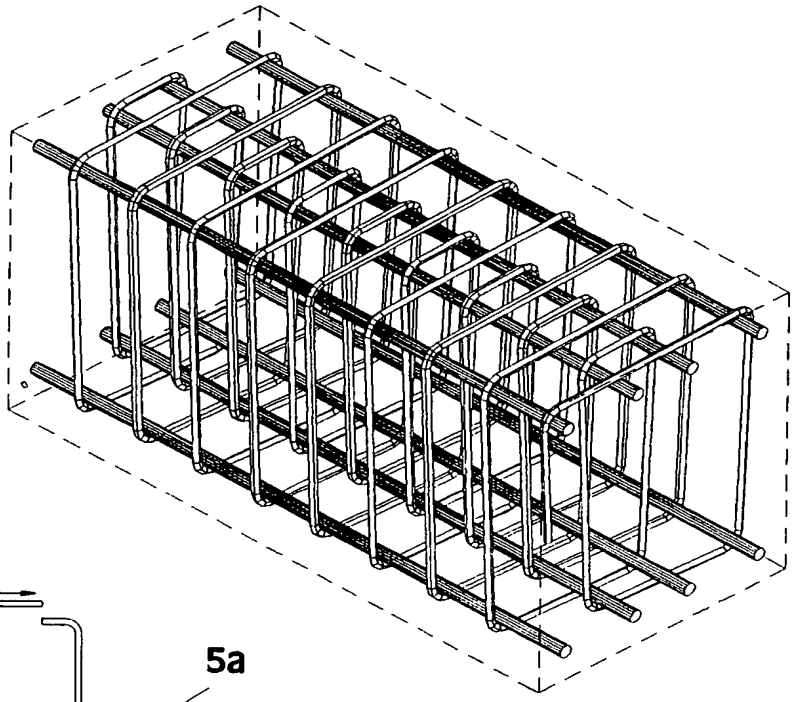


Figure 7

Figure 8



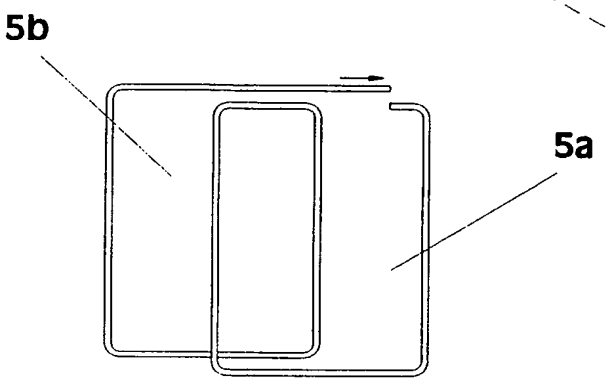


Figure 8a

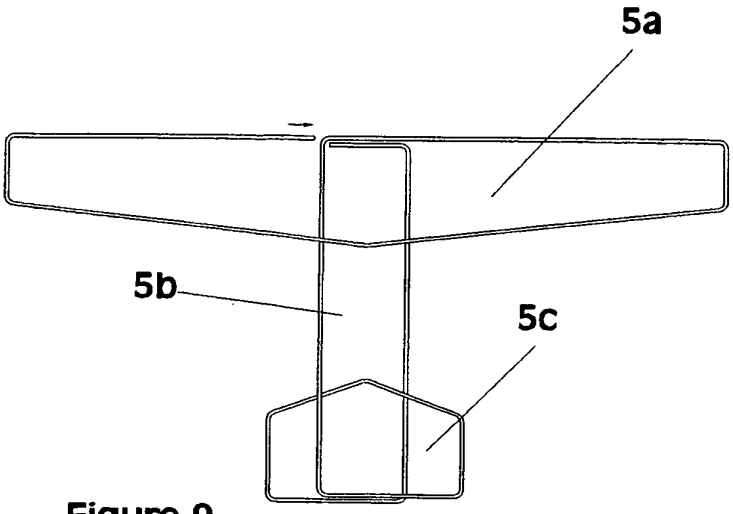
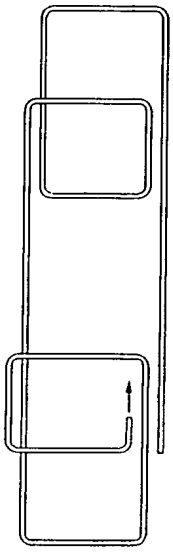


Figure 9

Figure 10a



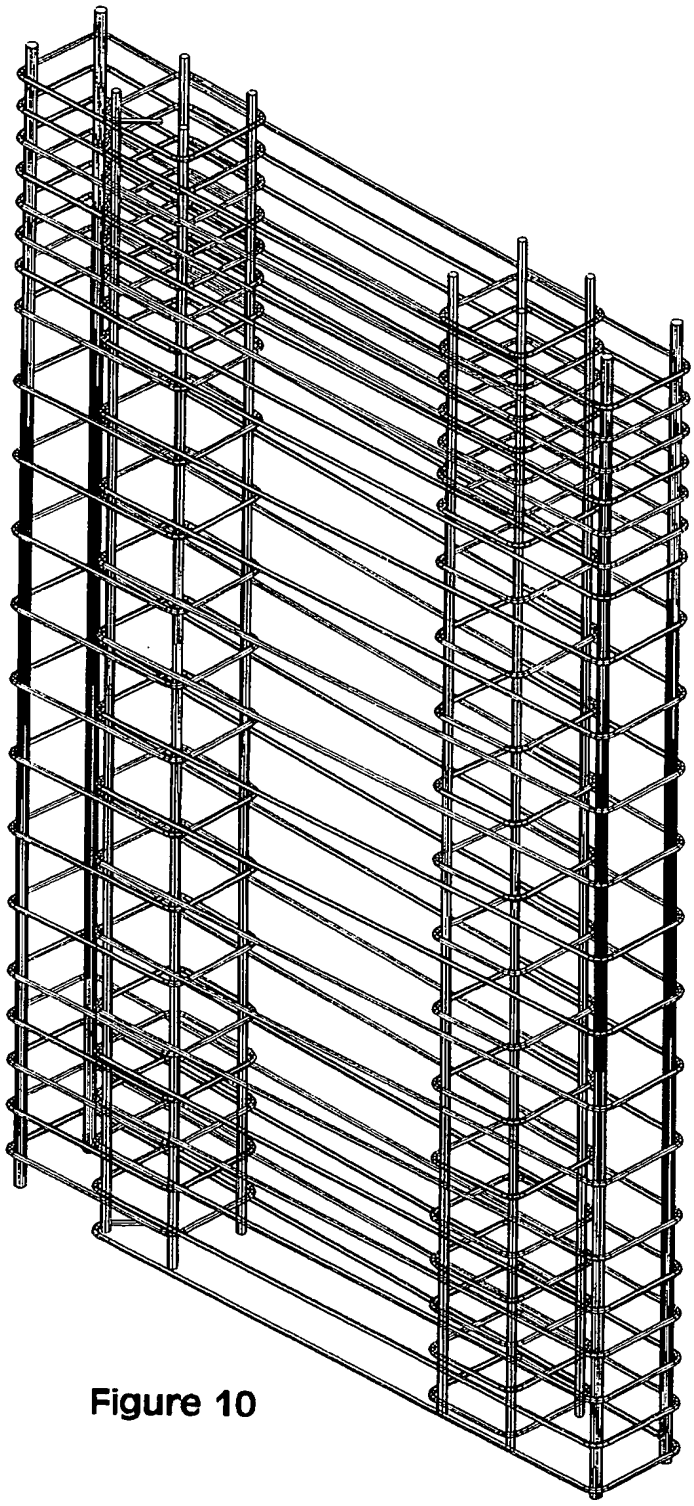


Figure 10

Figure 11a

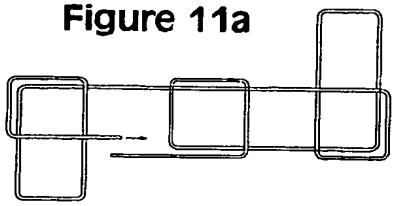


Figure 11d

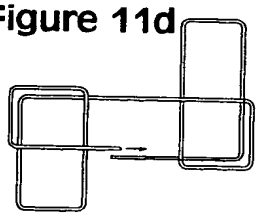


Figure 11b

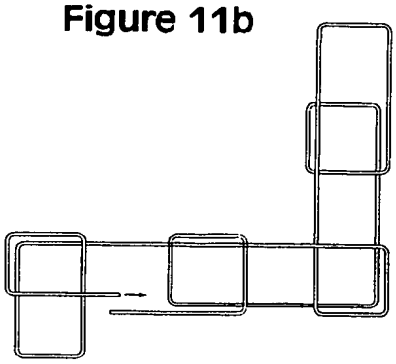


Figure 11e

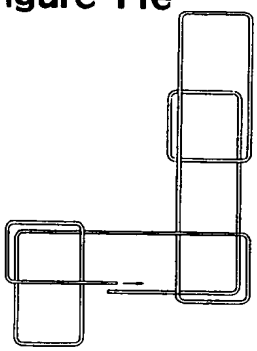


Figure 11c

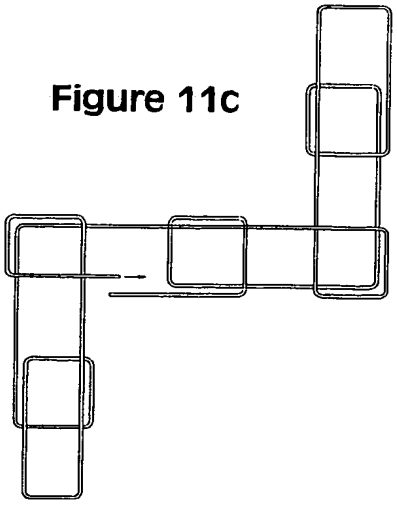
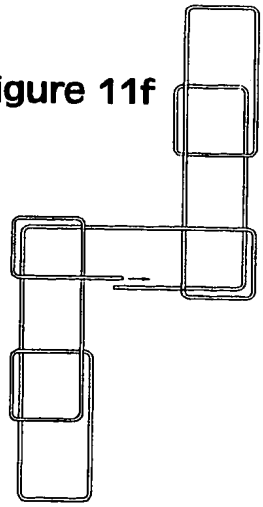


Figure 11f



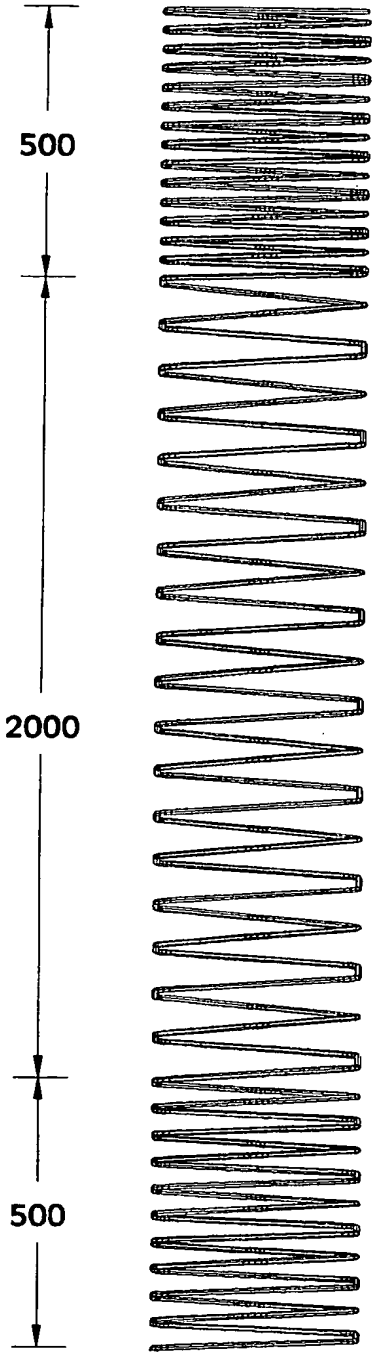


Figure 12

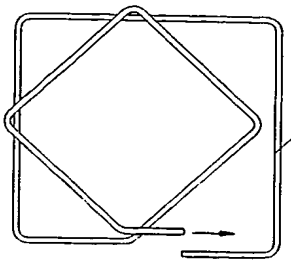


Figure 13a

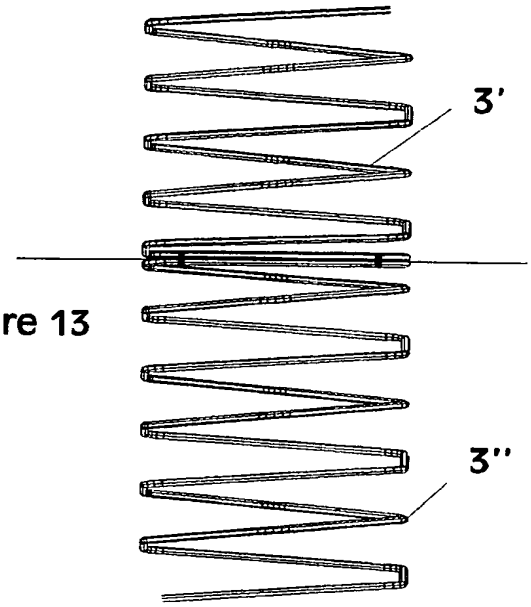


Figure 13

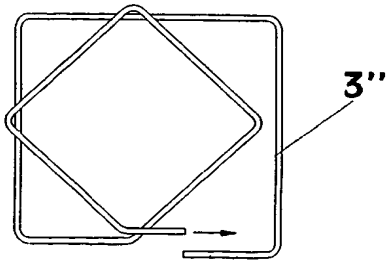


Figure 13b

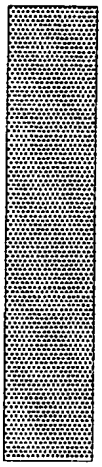


Figure 14

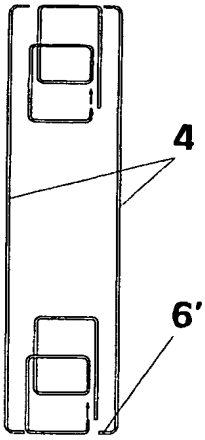


Figure 14a

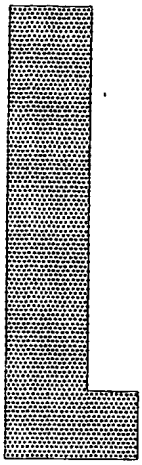


Figure 15

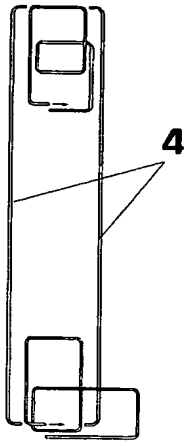


Figure 15a

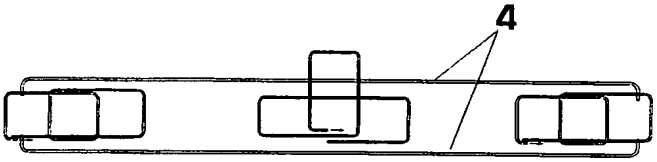


Figure 16a

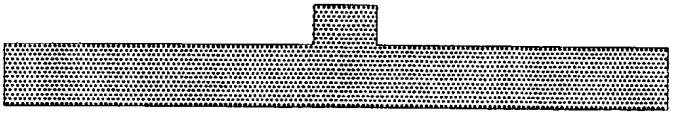


Figure 16

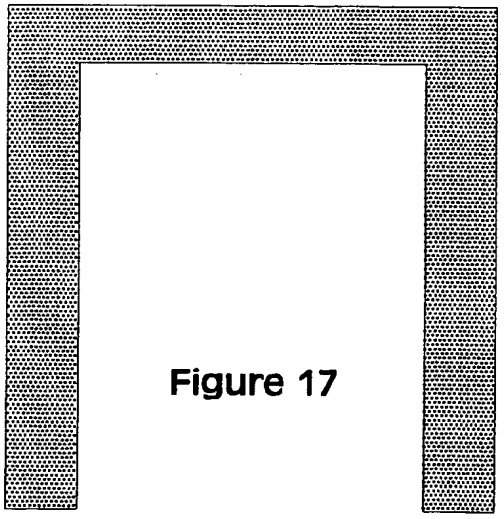


Figure 17

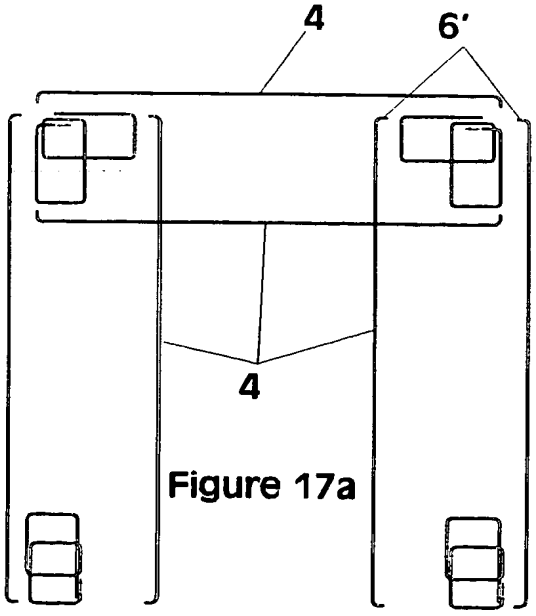


Figure 17a

INTERNATIONAL SEARCH REPORT

Inte; nal Application No
PCT/GR 97/00043

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E04C5/02 E04C5/06 E04H9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E04C E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 152 397 A (RAKENNUSVALMISTE OY) 21 August 1985 cited in the application	1-4,7,8, 10-19
A	see page 1, paragraph 4 - page 2, paragraph 3 see page 2, paragraph 7 - page 4, paragraph 2 see page 4, paragraph 8 - page 5, paragraph 5 see figures 1-10	5,6,9

X	AU 58674 69 A (KANZLER) 4 February 1971	1-3,7,8, 10-19
A	see the whole document	4-6,9

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 February 1998	04/03/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Righetti, R

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GR 97/00043

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 26 46 272 A (DYCKERHOFF & WIDMANN) 20 April 1978 see page 4, paragraph 3 see figures 1,2	1
A	US 4 119 764 A (MIZUMA ET AL.) 10 October 1978 see column 1, line 44 - column 1, line 63 see column 8, line 23 - column 8, line 63 see figures 4-6	1

INTERNATIONAL SEARCH REPORT

..formation on patent family members

Inter nal Application No
PCT/GR 97/00043

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0152397 A	21-08-85	DK 29985 A	25-07-85
AU 5867469 A		NONE	
DE 2646272 A	20-04-78	NONE	
US 4119764 A	10-10-78	NONE	

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GR 97/00043	31/12/1997	03/01/1997
Applicant		
KONSTANTINIDIS, Apostolos		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] **Certain claims were found unsearchable** (see Box I).

2. [ ] **Unity of invention is lacking** (see Box II).

3. [ ] The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] Transcribed by this Authority

4. With regard to the **title,**
   - [X] the text is approved as submitted by the applicant
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**
   - [X] the text is approved as submitted by the applicant
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International Search Report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is:
   Figure No. 3
   - [X] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GR 97/00043

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E04C5/02 E04C5/06 E04H9/02

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E04C E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 152 397 A (RAKENNUSVALMISTE OY) 21 August 1985 cited in the application	1-4,7,8, 10-19
A	see page 1, paragraph 4 - page 2, paragraph 3 see page 2, paragraph 7 - page 4, paragraph 2 see page 4, paragraph 8 - page 5, paragraph 5 see figures 1-10	5,6,9

X	AU 58674 69 A (KANZLER) 4 February 1971	1-3,7,8, 10-19
A	see the whole document	4-6,9

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 February 1998	04/03/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Righetti, R

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	DE 26 46 272 A (DYCKERHOFF & WIDMANN) 20 April 1978 see page 4, paragraph 3 see figures 1,2	1
A	US 4 119 764 A (MIZUMA ET AL.) 10 October 1978 see column 1, line 44 - column 1, line 63 see column 8, line 23 - column 8, line 63 see figures 4-6	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GR 97/00043

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0152397 A	21-08-85	DK 29985 A	25-07-85
AU 5867469 A		NONE	
DE 2646272 A	20-04-78	NONE	
US 4119764 A	10-10-78	NONE	

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PATENT COOPERATION TREATY

REC'D 27 JAN 1999
WIPO PCT

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference /	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (PCT/IPEA/416)
International application No. PCT/GR97/00043	International filing date *(day/month/year)* 31/12/1997	Priority date *(day/month/year)* 03/01/1997
International Patent Classification (IPC) or national classification and IPC E04C5/02		
Applicant KONSTANTINIDIS, Apostolos		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

I	☒	Basis of the report
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☒	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain documents cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
03/06/1998	25.01.99
Name and mailing address of the IPEA/ European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Authorized officer Cleuziou, Y Telephone No. (+49-89) 2399-2492

Form PCT/IPEA/409 (Cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GR97/00043

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1,3-8	as originally filed			
2,2a,9	as received on	14/11/1998	with letter of	10/11/1998

Claims, No.:

2-17	as originally filed			
1,18,19	as received on	14/11/1998	with letter of	10/11/1998

Drawings, sheets:

1/10-10/10	as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-19
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-19
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

1. Document EP-A-0 152 397, which is considered to represent the most relevant state of the art, discloses (cf. the whole document and in particular figures 4 to 10) a stirrup for reinforcing load bearing elements from which the subject-matter of independent claim 1 dif fers in that the plurality of the discrete cages are obtained with only one continuous wire.

2. In D1, but also in the cited documents AU-A-58 674 / 69 (D2) or DE-A-2 646 272 (D3), each cage is made with one wire and afterwards the entire cages are inserted within one another and/or welded together in order to obtain a stirrup with a plurality of discrete cages.

   There is no suggestion in the cited state of the art that the plurality of discrete cages could be made with **only one** continous wire.

   Consequently the subject matter of claim 1 is novel and inventive (Art. 33(2) and (3) PCT).

3. Claims 1 should have clearly expressed that the plurality of discrete cages is made with **only one** continous wire.

   This should also have been cleared in independent claims 16 to 19.

4. Figure 12 and the related passages of the description should have been deleted because the concerned stirrup has only **one** cage and not a plurality, which is in contradiction with claim 1.